Prepared by KMA,
Agenda Item: D.1
Discussed in Plenary

KMA REPORT ON THE STATUS OF CURRENT AND FUTURE SATELLITE

In response to CGMS action/recommendation

COMS (128.2^{O}E) MI is currently operational and data are distributed via landline and satellite over Western Pacific region, and COMS GOCI over East Asian region.

The progress of the development of GEO-KOMPSAT-2A (meteorological mission) and -2B (ocean and environmental mission) scheduled to be launched in May and December 2018, respectively.

*COMS : Communication, Ocean and Meteorological Satellite
*GOCI (Geostationary Ocean Colour Imager)
*KARI : Korea Aerospace Research Institute

Report on the status of current and future satellite systems

1 INTRODUCTION

COMS (Communication, Ocean, and Meteorological Satellite), the first Korean geostationary meteorological satellite, was launched successfully on June 27th, 2010 and has been operating at a longitude of 128.2°E since April 1st, 2011.

2 CURRENT SATELLITE SYSTEMS

Sector	Satellite in Orbit P=pre-operational Op=operational B=back-up L=limited availability	Operator	Location	Launch date	Details on near real time access to L0/L1 data (Link)	Environmental payload and status
West Pacific	COMS (Op)	KMA, KIOST	128.2°E	26/06/2010	HRIT specification LRIT specification	5-channel VIS/IR Meteorological Imager (MI), Geost. Ocean Colour Imager (GOCI) Direct Broadcast via HRIT/LRIT

2.1 Status of current GEO satellite systems

2.1.1 Mission objectives, payload/instruments, products

COMS meteorological mission is performed by MI (Meteorological Imager) with one visible channel and four infrared channels (Table 2.1).

The COMS MI observation data are disseminated to M/SDUS (Medium/Small Scale Data Utilization Stations) users in H/LRIT (High/Low Rate Information Transmission) formats within 15 minutes after the end of image scanning. Also, we provide high quality COMS MI level 1B data through land-based network via NMSC (National Meteorological Satellite Center) website (http://nmsc.kma.go.kr/jsp/homepage/eng/main.do) and FTP.

In this report, we introduce the current status and future plans of COMS MI operation performance and data services.

Table 2.1 : The channels of COMS/MI

Channel	Wavelength (㎛)	Spatial Resolution (km)
VIS	0.675	1 x 1
SWIR	3.75	4 x 4
WV	6.75	4 x 4
IR1	10.8	4 x 4
IR2	12.0	4 x 4

VIS: Visible SWIR: Shortwave Infrared
WV: Water Vapor IR: Infrared

The GOCI has 500m×500m pixel resolution (GSD) and a coverage area of 2,500km×2,500km covering Korea, Japan, the eastern coast of China, GOCI can acquire 16 slot images and compose one complete image of the GOCI coverage area at a center of 36˚N and 130˚E as shown in Figure 2.1. In addition, Table 2.2 presents the general specification of GOCI, which has an operational life of 7.7 years, and GOCI receives images eight times a day in hourly intervals from 00:15 GMT to 07:45 GMT.

Table 2.2: General Characteristics of COMS/GOCI

	GOCI on COMS
Volume Size(mm^3)	1,000 x 760 x 896
Weight	< 83.3 kg
Power	< 125 W
Digitization	12 bits
Resolution (GSD)	500 m @ point of 130°E, 36°N
Observation Period	1 hour (8 times earth observation per 1 day)
Field of regard	Local Area (2,500 km x 2,500km, Center: 130°E, 36°N)
Mission Life Time	7.7 years

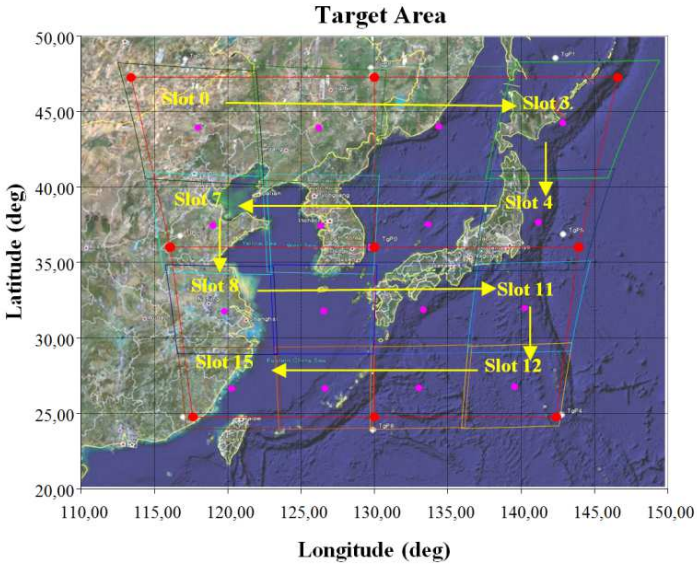

Figure 2.1: The target area of GOCI

2.1.2 Status of spacecraft

Since April 2011, the COMS mission is under the normal operation 24 hours a day 365days a year. The normal operation of the COMS is conducted by the Korea Aerospace Research Institute (KARI) using the Satellite Ground Control System (SGCS) in the Satellite Operation Center (SOC) of the KARI.

The COMS spacecraft is currently under normal operation without any problem to support the meteorological observation mission and the ocean monitoring mission.

2.1.3 Impact on spacecraft due to space weather

Not applicable

2.1.4 Ground segment matters

The success rate of MI H/LRIT broadcast can be the standard of operation and real-time data service. We analysed the success rate from April 1, 2011 to March 31, 2014. The success of broadcast means that MI H/LRIT image data dissemination is completed within 15 minutes after the end of image scanning.

- Period: 04.01. 2011 ~ 03.31. 2014 (36 months)
- H/LRIT (disseminated/planned): 92,280/92,455(* 99.81 %)
  * The broadcasts by backup site antenna are included

The broadcast failure cases were caused by ground system anomaly such as antenna and pre-processing system faults.

2.1.5 Data transmission

The observed meteorological data by COMS MI are broadcast to medium/small-scale data utilization stations (MDUS/SDUSs) after being converted into HRIT (High Rate Information Transmission) and LRIT (Low Rate Information Transmission) formats (Table 2.3). We provide the H/LRIT services free of charge and transmit encrypted data to identify the users of H/LRIT. The domestic and foreign MDUS/SDUSs that wish to use our services should make a formal application using the procedures outlined on the website of the National Meteorological Satellite Center (http://nmsc.kma.go.kr/jsp/homepage/eng/contents/etc/member.jsp). The technical documentations to learn about the application procedures for becoming a user station and the means to decrypt the encrypted data are posted on the website.

Figure 2.2: Concept of MI H/LRIT direct broadcasting

Currently, the FD and ENH images are broadcasted in both H/LRIT and three kinds of level 2 meteorological products images (cloud top temperature (CTT), cloud top pressure (CTP), cloud top height (CTH)) and GOCI images are broadcast in only LRIT. Figure 2.3 shows H/LRIT dissemination schedule which has officially carried out since April 1st, 2011.

Table 2.3: Classification of H/LRIT

Classification	HRIT	LRIT
Data Transmission Rate	3 Mbps	512 kbps
Data Types	MI image Alpha numeric text Encryption key message	MI image Alpha numeric text Encryption key message GOCI image Satellite meteorological products(Cloud Top Temperature, Cloud Top Pressure, Cloud Top Height)
Image mode	FD, ENH	FD, ENH
User Station	MDUS	SDUS

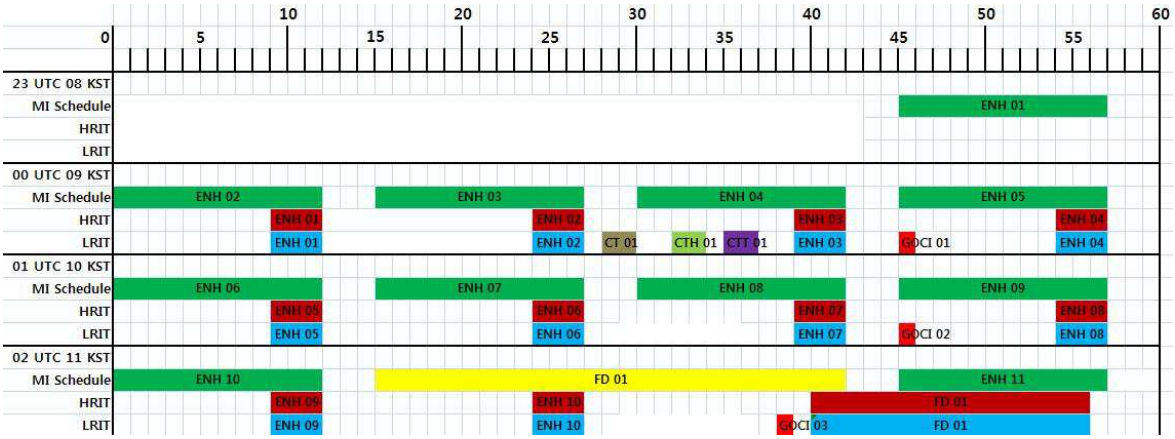

Figure 2.3: Sample of COMS MI H/LRIT dissemination schedule

The MOF issued the GOCI data distribution policy as the Minister's instruction. In the instruction, GOCI data can be distributed free of charge only for public/research purposes. But it takes payments for special request and commercial use. The intellectual property of both GOCI and GOCI data is belonged to the MOF and the re-distribution to third parties of distributed data is limited. The standard products passed the calibration and validation is only distributable on website or on the file transfer service. A distribution is based on this instruction.

The GOCI data has been provided as HDF-EOS5 (He5) format using the orthographic map projection. For a stable distribution service of GOCI data, various systems were installed in KOSC. KOSC developed GOCI Data Distribution System (GDDS) and a website (http://kosc.kiost.ac) to distribute geo-corrected satellite data and browsing image. GDDS has been distributed GOCI data to the users since April 2011 on this website restrictively. Some of GOCI level 2 data (Chl, TSS, CDOM, Lw, nLw) are available and GDPS for user can be downloaded in the web site.

All what users to do is to access to web server for the data searching. User can search data as specified date and sensor. Basic selected options are including sensor name, time, date1, date2 and amount of clouds, searching area and each products of each sensor in advanced selections. The function of cart and saving condition is added for user's convenience. User can download the searched/requested data from the data server through download component.

Data distribution for dedicated institution is performed by FTP push method. There are 16 domestic institutions which are getting the GOCI data through the FTP service from KOSC. Interested in using the FTP service, an institution, who wants to receive the satellite data in near-real time, can fill out an application and send it to KOSC. But the institution should prepare the FTP system for receiving the data. It is just to minimize inconvenience of users by avoiding overloading the KOSC system. If there is no problem on the application through the review, KOSC will announce the start date to you by e-mail. Then the data will be sent from KOSC FTP to your system and the report on the transmission also sent you every day by e-mail. The report includes

the result and information of the provided data. If there is any missed data, re-transmission can be required.

2.1.6 Projects, services

(1) Service via Satellite

Please refer to 2.1.5.

(2) Service via Landline

The NMSC provides COMS level 1B data of all five channels and level 2 products to users by posting the processed data on NMSC website (http://nmsc.kma.go.kr/jsp/eng/contents/main/main.jsp). All registered members of the website can log on, search, and download those data up to 3GB and 500 files for one time request. Here is the list of COMS meteorological products open to users.

Table 2.4: The list of COMS MI products

No.	Products	Resolution	Period	Start Date of Service
1	Cloud analysis (cloud type, phase and amount)	4 km	15 min.	1 Apr. 2011
2	Cloud top pressure/temperature/height	4 km	15 min.	
3	Atmospheric Motion Vector (AMV)	64 km	1 hour	
4	Cloud detection	4 km	15 min.	
5	Fog	4 km	15 min.	
6	Aerosol index (AI)	4 km	15 min.	
7	Sea surface temperature (SST)	4 km	1-, 5-, 10-day composition	10 Aug. 2011
8	Rain intensity (RI)	4 km	15 min.	
9	Outgoing longwave radiation (OLR)	4 km	1 day	
10	Upper tropospheric humidity (UTH)	36 km	15 min.	
11	Land Surface Temperature	4 km	15 min.	10 Feb. 2012
12	Snow and Sea Ice	4 km	1 day/8 day	
13	Total Precipitation	4 km	15 min.	
14	Clear Sky Radiance	28 km	15 min.	

Currently near real-time FTP service of COMS HRIT data is only open to organizations which has MOU conclusion for data exchange with NMSC such as NESDIS, EUMETSAT. Last seven days of COMS HRIT data are stored in FTP disk, so the authorised organization can get those data via land-based network once they get FTP account of it.

Contact information for request FTP account: kmasod@korea.kr

(3) DCPC-NMSC

As a part of WIS DCPC project lead by WMO, NMSC accomplished the construction of DCPC-NMSC and started normal operation on 29th March 2013 for providing COMS meteorological data as below list.

- All five channels level 1B in binary and graphic file format
- Eleven level 2 products in binary and graphic file format
  (1) Cloud detection
  (2) Land surface temperature
  (3) Total precipitable water
  (4) Cloud analysis (cloud top temperature/pressure/height, cloud type, cloud amount, cloud phase, cloud optical thickness)
  (5) Fog
  (6) Rainfall Intensity
  (7) Atmospheric motion vector
  (8) Sea surface temperature
  (9) Sea ice/snow cover detection
  (10) Outgoing longwave radiance
  (11) Clear Sky Radiance

The registered user can search, access, download the COMS meteorological data on this user portal web address : http://dcpc.nmsc.kma.go.kr

Figure 2.4: Main page of DCPC-NMSC website

2.1.7 User statistics

(1) Domestic

NMSC provides COMS data to 23 domestic KMA-related organizations (increased by 2 compared to 2013) via FTP in real time such as the military, broadcasting companies, disaster prevention centers, and local governments. To receive COMS L/HRIT data, 5 MDUSs and 5 SDUSs (increased by 1 compared to 2013) have been installing at 10 organizations: Air Force, National Fisheries Research and Develop Institute, Korea Meteorological Industry Promotion Agency, Seoul Emergency Management Center, National Science Center and so on since 2011. To get COMS data via Internet, 329 members (increased by 129 compared to 2013) are registered on NMSC website until end of January 2014.

(2) International

Currently, 6 MDUSs and 4 SDUSs have been installed at 6 foreign organizations since 2011 including Air Force weather Agency of US (Guam and Okinawa), Department of Meteorology of Sri Lanka, Central Weather Bureau of Taiwan, Japan Agency Marine-Earth Sciences and Technology, Chulalongkorn University in Thailand, Vietnamese Air Force and Air Defence and 3 private companies.

For ODA (Official Development Assistance) activities, KMA will support COMS receiving, processing systems and education program for the Philippines being managed by KOICA (Korea International Cooperation Agency) for two years from 2014 as a follow-up project for Sri Lanka which was accomplished in 2012 and keep planning to extend this kind of project to any other Asian user countries such as the Laos, Vietnam, Fiji etc.

2.2 Status of current LEO satellite systems

Not applicable

2.3 Status of current HEO [or other] satellite systems

Not applicable

2.4 Status of current R&D satellite systems

Not applicable

3 FUTURE SATELLITE SYSTEMS

Sector	Satellite in Orbit P=pre-operational Op=operational B=back-up L=limited availability	Operator	Location	Launch date	Details on near real time access to L0/L1 data (Link)	Environmental payload and status
West Pacific	GEO-KOMPSAT-2A	KMA	128.2°E	May, 2018		Advanced Meteorological Imager (AMI), Space Environmental monitoring payload Direct broadcast via HRIT/LRIT
	GEO-KOMPSAT-2B	MOF(Ministry of Oceans and Fisheries), ME(Ministry of Environment)	128.0°E	December, 2018		Advanced Geostationary Ocean Colour Imager(GOCI-II), Geostationary Environmental Monitoring Spectrometer(GEMS)

3.1 Status of future GEO satellite systems

KMA is planning for the follow-on geostationary meteorological satellite (GEO-KOMPSAT-2) to continue the COMS's meteorological and oceanographic mission. GEO-KOMPSAT-2 program had been started under the cooperation with Ministry of Science, ICT and Future Planning (MSIP), Ministry of Oceans and Fisheries (MOF), and Ministry of Environment (ME) of Korean government, and kicked off in the middle of 2012.

The GEO-KOMPSAT-2 consists of a pair of satellites for multi-purpose. One (GEO-KOMPSAT-2A) is for meteorological mission-only. The other (GEO-KOMPSAT-2B) is for ocean and environmental missions. Ocean mission is to monitor the ocean colour using an advanced GOCI (Geostationary Ocean Colour Imager) continuously. The environmental mission is to monitor atmospheric environments globally with the first payload carried on the geostationary satellite. The GEO-KOMPSAT-2A and -2B satellites will be launched in May, and December 2018, respectively.

3.1.1 Mission objectives, spacecraft, payload/instruments, products

Observation mission

The Advanced Meteorological Imager, the payload for meteorological mission of GEO-KOMPSAT-2A, is comparable to those of the ABI and AHI imager on board Himawari-8/9 and GOES-R. The development of AMI was kicked off in April 2013. The detailed specification of AMI is as follows:

- Multi-channel capacity: 16 channels (4 visible, 2 near-infrared and 10 infrared channels)
- High spatial resolution: 0.5-1.0 km for visible and 2 km for infrared channels
- Fast imaging: within 10 minutes for Full Disk observation
- Flexibility for the regional area selection and scheduling

The channel characterizations of the AMI are summarized in Table 3.1.

Table 3.1: Channel characterizations of the AMI for the GEO-KOMPSAT-2A satellite

Bands		Center Wavelength		Band Width (Max, um)	Resolution (km)	SNR	NEdT(K) (240/300K)	Radiometric Accuracy
		Min(um)	Max(um)					
VNIR	VIS0.4	0.431	0.479	0.075	1	250		5%
	VIS0.5	0.5025	0.5175	0.0625	1	250		5%
	VIS0.6	0.625	0.66	0.125	0.5	120		5%
	VIS0.8	0.8495	0.8705	0.0875	1	210		5%
	NIR1.3	1.373	1.383	0.03	2	300		5%
	NIR1.6	1.601	1.619	0.075	2	300		5%
MWIR	IR3.8	3.74	3.96	0.5	2		3/0.2	1K
	IR6.3	6.061	6.425	1.038	2		0.4/0.1	1K
	IR6.9	6.89	7.01	0.5	2		0.37/0.1	1K
	IR7.3	7.258	7.433	0.688	2		0.35/0.12	1K
	IR8.7	8.44	8.76	0.5	2		0.27/0.1	1K

LWIR	IR9.6	9.543	9.717	0.475	2		0.35/0.15	1K
	IR10.5	10.25	10.61	0.875	2		0.4/0.2	1K
	IR11.2	11.08	11.32	1.0	2		0.19/0.1	1K
	IR12.3	12.15	12.45	1.25	2		0.35/0.2	1.1K
	IR13.3	13.21	13.39	0.75	2		0.48/0.3	1.1K

※ SNR@100% albedo, NEdT@240/300K, calibration accuracy@100% albedo/300K

Korean Space Environment Monitor, KSEM, is the instrument for the secondary mission of GEO-KOMPSAT-2A satellite to observe the space weather. The suite of KSEM instruments consists of particle detector (PD); magnetometer (MAG); satellite charging monitor (SCM); and on-board Instrument Data Processing Unit (IDPU). The sensors is used to monitor the space weather condition of high-impact space storms, the radiation environment hazardous to spacecraft, aircraft and radio communication for 24 hours/7 days during 10 years mission life time. The design of PD is inherited from THEMIS (Time History of Events and Macroscale Interactions during Substorms) SST (Solid State Telescope, which is NASA mission to investigate how Earth magnetosphere works and the important Sun-Earth connection. MAG shown left is THEMIS FGM (FluxGate Magnetometer). The detailed design of KSEM magnetometer will be decided. SCM shown in the bottom of left side of the Figure 3.1 measure the satellite internal charging.

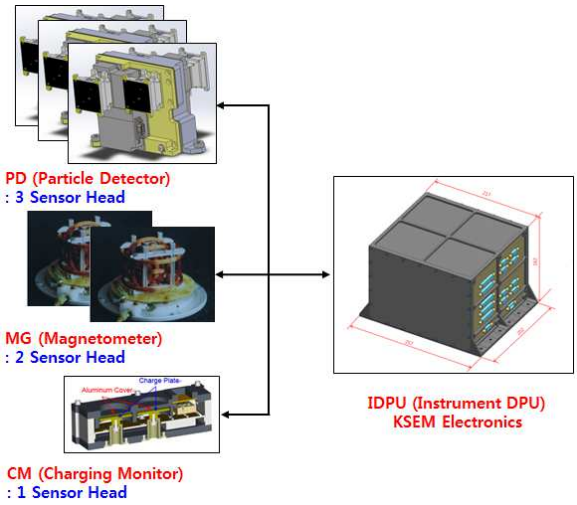

Figure 3.1: KSEM components and its preliminary design

The preliminary studies for ground segment and meteorological data processing system have been carrying out from 2011 to 2013, and the development will be kicked off in the first half of 2014.

In addition to AMI in GEO-KOMPSAT-2A, Geostationary Ocean Colour Imager-II (hereinafter “GOCI-II”) is another payload under the GEO-KOMPSAT-2 program. Korea Institute of Ocean Science & Technology (hereinafter “KIOST”), independent national institute established by dedicated law, is responsible for the definition of mission and user requirements, and for the operation of GOCI-II.

GOCI-II is a next generation of GOCI, one of the major payloads in COMS, which is the 1st ocean colour imager in the world operating on the geostationary orbit. GOCI has been developed to provide a monitoring of ocean colour around the Korean Peninsula to detect, monitor, quantify, and predict short term changes of coastal ocean environment for marine science research and application purpose. GOCI-II is expected to have largely enhanced radiometric/geometric performance in comparison with GOCI.

Table 3.2 shows the spectral bands and radiance performance of GOCI-II including the new spectral bands. Additional spectral bands will be expected to perform specific coastal monitoring and application researches as well as more accurate atmospheric correction will be possible in this research area.

Table 3.2: Spectral Bands and Radiance Performance of GOCI-II

Band	Band Center	Band-width	Nominal Radiance	Maximum Ocean Radiance	Threshold Radiance	Maximum Cloud Radiance	SNR @ nominal radiance
1	380 nm	20 nm	93	139.5	143.1	634.4	998
2	412 nm	20 nm	100	150.0	152.0	601.6	1,050
3	443 nm	20 nm	92.5	145.8	148.0	679.1	1,145
4	490 nm	20 nm	72.2	115.5	116.0	682.1	1,228
5	510 nm	20 nm	64.9	108.5	122.0	665.3	1,180
6	555 nm	20 nm	55.3	85.2	87.0	649.7	1,124
7	620 nm	20 nm	53.3	64.1	65.5	629.5	1,102
8	660 nm	20 nm	32.0	58.3	61.0	589.0	1,060
9	680 nm	10 nm	27.1	46.2	47.0	549.3	914
10	709 nm	10 nm	27.7	50.6	51.5	450.0	914
11	745 nm	20 nm	17.7	33.0	33.0	429.8	903
12	865 nm	40 nm	12.0	23.4	24.0	343.8	788
13	wideband		-	-	-	-	-

※ Spectral radiances values are in $Wm^{-2}\mu m^{-1}sr^{-1}$

Ministry of Environment (ME), Korea, is developing the payload (GEMS; Geostationary Environmental Monitoring Spectrometer) for atmospheric composition measurements in the Asia-Pacific region. Feasibility studies for the subsystem, system level and scientific missions had been finished. For the air quality mission, ME formally established the Global Environmental Satellite Program Office in June 2009, in the National Institute of Environmental Research (NIER) of ME.

GEMS will contribute to the understanding of the globalization of pollution events, source/sink identification, and long-range transport of pollutants and short-lived climate forcers (SLCFs), as a part of the activities of Atmospheric Composition Constellation under the Committee on Earth Observation Satellites (CEOS). This Constellation coordination activity is focused on collaboration to improve and extend data utilization from the planned missions. The missions now funded are: Korea (GEMS), Europe (Sentinel-4), and the US (TEMPO) will enable the “baseline” constellation data products.

GEMS is expected to contribute monitoring air quality and SLCFs including ozone and aerosols in Asia in high temporal and spatial resolution. Using a scanning UV-Visible spectrometer, its observations can contribute to provide a set of tropospheric column products over the Asia-Pacific region at spatial resolution of ~ 8 km and temporal resolution of 1 hour. Other products include NO2, HCHO, SO2, and aerosol optical depth.

Table 3.3 shows GEMS requirements for mission success and Figure 3.2 the configuration of GEMS.

Table 3.3: Payload Requirement of GEMS

Item	Requirement
Lifetime	> 10 years after IOT
Reliability	> 0.85 @ 7 years
Field of regard	> 5,000 km(N/S) × 5,000 km(E/W) N/S: 45°N ~ 5°S, E/W: Selectable between 75°E ~ 145°E
Duty cycle/Imaging time	8 images during daytime (30 min imaging + 30 min rest) × 8 times/day
Ground sampling distance	< 7 km(N/S) at Seoul GSD area < 56km^2 at Seoul(Aspect ratio shall be less than 1:3)
Spectral range	300 nm to 500 nm
Spectral resolution	< 0.6 nm
Spectral sampling	< 0.2 nm
Signal-to-noise ratio	> 720 @ 320 nm > 1500 @ 430 nm
Data quantization	≥ 12 bits
MTF (Instrument level)	> 0.3 in N/S direction @ Nyquist frequency > 0.3 in E/W direction @ Nyquist frequency
Radiometric calibration accuracy	< 4%
Spectral calibration accuracy	< 0.02 nm
Polarization factor	< 2% (310-500 nm) No inflection point within 20nm for all wavelength range

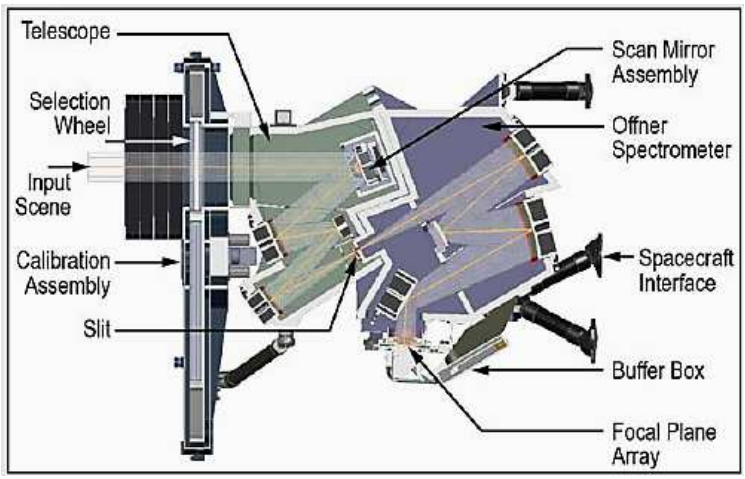

Figure 3.2: Configuration of system and subsystem of GEMS

The schedule for GEO-KOMPSAT-2A and 2B program is shown in Figure 3.3.

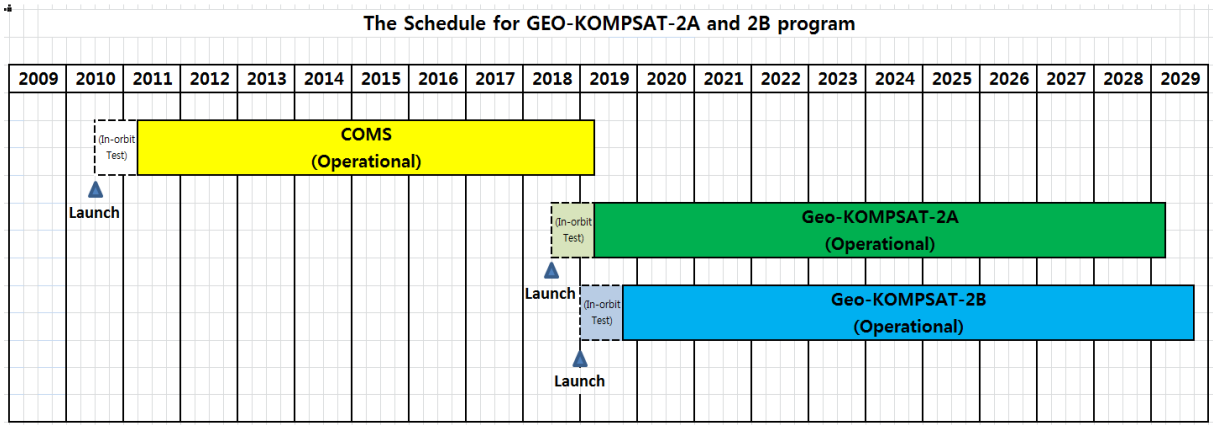

Figure 3.3: Schedule for the GEO-KOMPSAT-2

3.1.2 Ground segment matters

NMSC/KMA is planning to develop the ground segment that will receive data from Geo-KOMPSAT-2A spacecraft, generate real-time Geo-KOMPSAT-2A meteorological/space weather products and disseminate data via Geo-KOMPSAT-2A broadcasting. The top-notch Information & Communication Technologies and scientific capabilities will be applied to handle the vast volume of Geo-KOMPSAT-2A data in real-time manner consistent with user requirements.

For non-stop operation and real-time data service, back-up systems will be equipped for all components and the remote data storage concept will be implemented for enhancing data security.

The timeline of Geo-KOMPSAT-2A ground segment development consists of three phases as below:

- Phase 1 (2014~2015) : System Design and Algorithm Development
- Phase 2 (2016~2017) : Implementation and Integration
- Phase 3 (2018~2019) : In-orbit Ground Test and Preparation of Normal Operation

The Figure 3.4 displays the time schedule of Geo-KOMPSAT-2A ground segment development, which might be modified according to the Geo-KOMPSAT-2A satellite development progress and budgeting for this project.

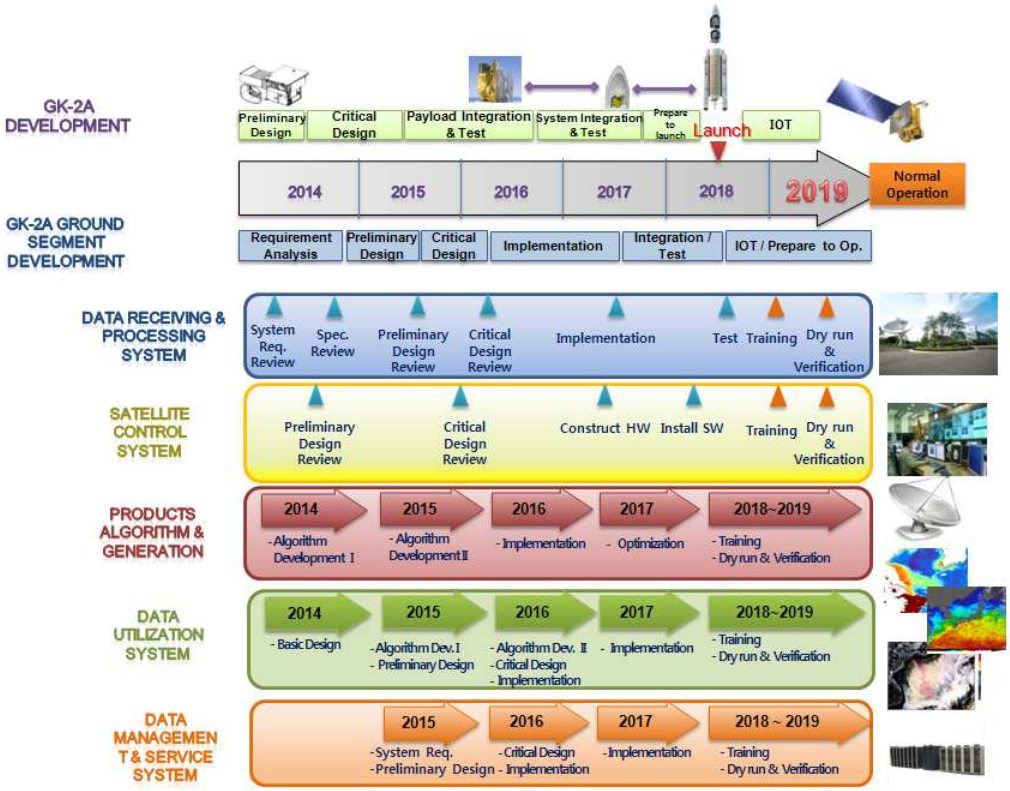

Figure 3.4: Schedule for the space/ground segment development of the GEO-KOMPSAT-2A

3.1.3 Data transmission

The baseline of data broadcast policy for GeoKOMPSAT-2A is to disseminate all 16 channels data of meteorological observations in Ultra HRIT (tentatively named as UHRIT) and to maintain H/LRIT broadcast corresponding to COMS five channels. Below table is the current status of international registration request of frequency for Geo-KOMPSAT-2A which was submitted to International Telecommunication Union (ITU) on June 4th, 2012. The uplink/downlink frequency domains for Geo-KOMPSAT-2A mission will be determined afterward within the requested bandwidth of each frequency band.

Table 3.4: International frequency registration request for Geo-KOMPSAT-2A.

Category	Uplink (MHz)	Downlink (MHz)
L-Band	-	1670 ~ 1710 (for L/HRIT)
S-Band	2025 ~ 2110 (for UHRIT)	2200 ~ 2290 (for UHRIT)

X-Band	8175 ~ 8215 (for UHRIT)	7450 ~ 7550 (for Sensor Data & UHRIT)
	-	8025 ~ 8400 (for Sensor Data & UHRIT)

3.2 Status of future LEO satellite systems

3.2.1 KOMPSAT-5 program

The KOMPSAT (KOrean Multi-Purpose SATellite) program is a government funded space program which was started in the mid 90's. The first satellite of the KOMPSAT program was launched in 1999 and the second satellite was launched in 2006. Currently, KOMPSAT-5 (Figure 3.5) was launched in August 22nd 2013 on a Dnepr-1 launch vehicle of ISC Kosmotras from the Dombarovsky Launch Site, Yasny, Russia.

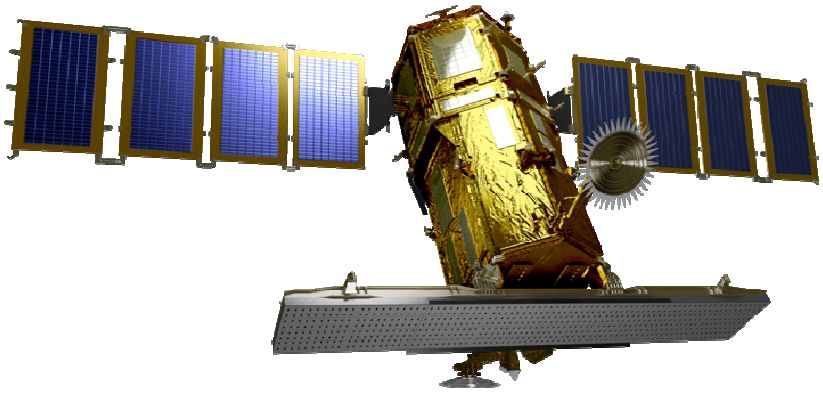

Figure 3.5: KOMPSAT-5

The main mission of KOMPSAT-5 is the Earth Observation by using a Synthetic Aperture Radar (SAR). In Figure 3.6, the KOMPSAT-5 program architecture is described. KARI (Korea Aerospace Research Institute) is a primary contractor of KOMPSAT-5 development and SAR Payload operation. KASI (Korea Astronomy and Space Science Institute) is in charge of the development of Atmosphere Occultation and Precision Orbit Determination (AOPOD) secondary payload which includes a dual frequency GPS receiver and a laser retro reflector Array (LRRA).

Figure 3.7 shows the KOMPSAT-5 dual frequency GPS receiver and LRRA. A dual frequency GPS receiver is used for generation of POD (Precision Orbit Determination) data and GPS Radio Occultation (RO) science data. The LRRA is used for POD validation of KOMPSAT-5.

RO products became one of the key observation data for space environment, atmospheric science, and meteorological applications. Since 2007, many national meteorology agencies have assimilated the RO data to the operational weather forecasting. Currently, KOMPSAT-5 RO data have been in initial test and are expected to contribute a global RO sounding coverage and international user community.

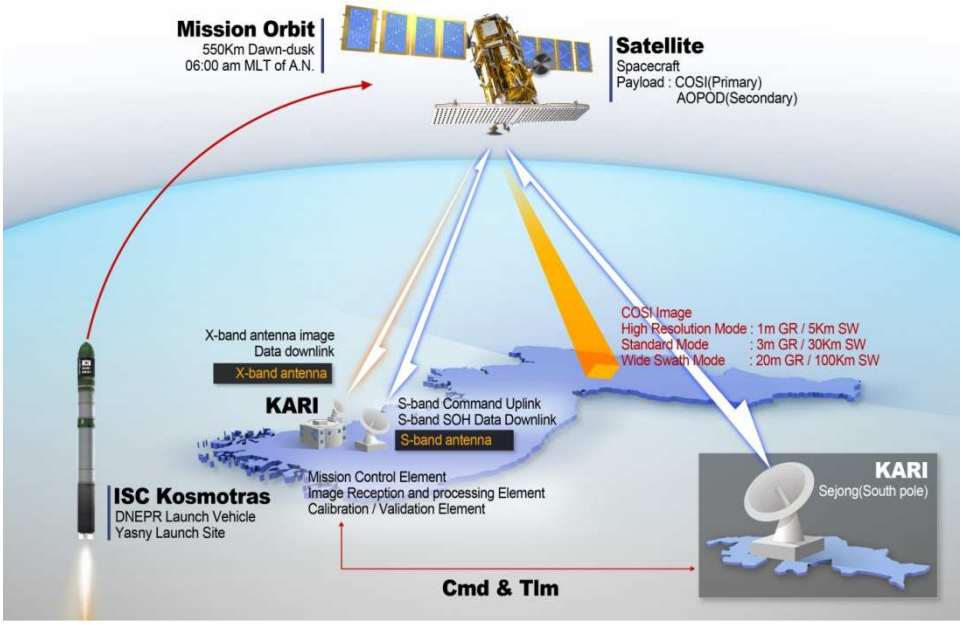

Figure 3.6: KOMPSAT-5 Program Architecture

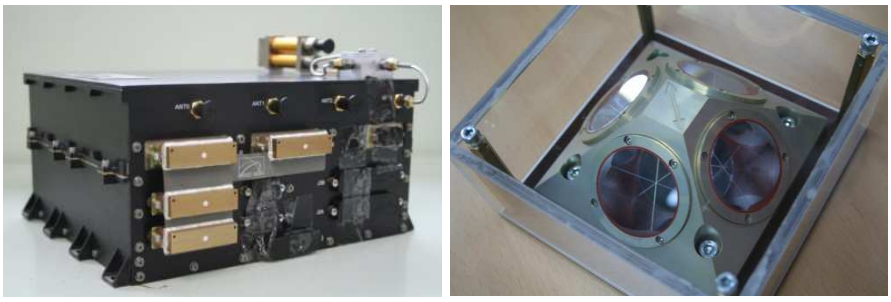

Figure 3.7: Spaceborne GPS Receiver and LRR

3.2.1.1 Mission objectives, payload/instruments, products

The mission orbit of KOMPSAT-5 is a sun-synchronous dawn-dusk circular orbit with an average altitude of 550 Km which provides about 15 revolutions per day. In Table 3.4, the KOMPSAT-5 orbital elements are listed.

Table 3.4: Mission Orbit of KOMPSAT-5

Orbital Elements	Mean Values
Semi-Major Axis (km)	6928.114
Eccentricity	0.00107
Inclination (deg)	97.60
R.A of Ascending Node (deg)	339.73
Argument of Perigee (deg)	90.0
Mean Anomaly	270.0

For KOMPSAT-5, the occultation mission is a secondary mission. The KOMPSAT-5 has two occultation antennas for observation of a rising and setting occultation. The data from two POD antennas are utilized together with occultation data. The observed occultation data, approximately 500events/day (maximum), are stored in the Solid State Recorder (SSR) and collected by the spacecraft's 1553B bus interface. The Data downlink to the ground station is via S-band telemetry.

3.2.2 Ground segment matters

KOMPSAT-5 program operates one ground station located in Daejeon. The baseline period of data publication is twice a day since KOMPSAT-5 contacts the Daejeon ground station twice a day.

3.2.3 Data transmission

The RO data of KOMPSAT-5 will be released to public users. KASI plans to release raw data and products in cooperation with UCAR (University cooperation for atmospheric Research). The data and processed products by KASI and UCAR will be stored and released to public users from KASI data center and UCAR data center. Since the number of ground contact of KOMPSAT-5 is only twice a day, a near real time data is not available. The expected date of the first public release of KOMPSAT-5 RO data is September, 2014.

3.3 Status of future HEO [or other] satellite systems

Not applicable

4 ACTIONS AND/OR RECOMMENDATIONS FOR CONSIDERATION BY CGMS PLENARY SESSION

Not applicable

5 CONCLUSIONS